CLAIMS

What is claimed is:

1. A tool comprising:

a drive shaft having proximal and distal ends, an intermediate portion, an outer sleeve engaging portion and a length;

a handle portion associated with the drive shaft proximal end,

a fastener engaging portion associated with the drive shaft distal end, the fastener engaging portion comprising a first surface configured to axially engage a fastener and a second surface configured to rotationally engage the fastener; and

an outer sleeve associated with the drive shaft intermediate portion, the sleeve comprising a drive shaft engaging portion,

wherein the outer sleeve engaging portion and the drive shaft engaging portion are configured to coact to allow at least a portion of the drive shaft to translate linearly within the sleeve.

2. The tool of claim 1, wherein the drive shaft comprises a cannulated fastener driving portion and an inner shaft portion, at least a portion of the inner shaft portion disposed within the fastener driving portion, the inner shaft portion configured to axially engage the fastener and the driving portion configured to rotationally engage the fastener.

3. The tool of claim 2, wherein the fastener driving portion further comprises:

a driving sleeve having a distal end comprising a fastener driving end and a bore having an inner surface, and

a shaft portion comprising a distal end having a driving sleeve cooperating portion, and a cannulation for receiving the inner shaft portion of the drive shaft,

wherein the distal end of the shaft portion is slidably received within the bore of the driving sleeve, and the bore and the driving sleeve cooperating portion are configured such that rotating the inner sleeve rotates the driving sleeve.

4. The tool of claim 3, wherein the inner shaft further comprises a radial groove, the shaft portion of the fastener driving portion further comprises a slot, and the driving sleeve further comprises a pin bore, wherein a pin disposed within the pin bore and extending through the slot to engage the radial groove fixes the inner shaft and the driving sleeve axially with respect to each other.

5. The tool of claim 4, wherein when the inner shaft axially engages the fastener, the driving sleeve also engages the fastener.

6. The tool of claim 1, wherein the inner shaft portion is tapered and the cannulated fastener driving portion is configured to slidingly receive the tapered inner shaft.

7. The tool of claim 1, wherein the axial fastener-engagement portion comprises a thread.

8. The tool of claim 1, wherein the first surface comprises at least one radial member configured to axially engage a recess in the head of a bone fastener.

9. The tool of claim 8, wherein the first surface comprises a plurality of radial members, each of which is configured to axially engage corresponding recesses in a fastener head.

10. The tool of claim 1, wherein the axial fastener-engagement portion grips the fastener about an outside surface of the fastener head.

11. The tool of claim 1, wherein the sleeve engaging portion and drive shaft engaging portions comprise complementary threads.

12. The tool of claim 1, further comprising an inner shaft having a fastener engaging surface at one end, the drive shaft further comprising a cannulation configured and sized to

accept at least a portion of the inner shaft, wherein when the inner shaft is disposed within the cannulation the fastener engaging surface extends distally beyond the distal end of the drive shaft.

13. The tool of claim 1, wherein at least a portion of the sleeve has a roughened outer surface.

14. The tool of claim 1, the fastener engaging portion further comprising a locking clip expanding portion, the fastener disposed within a fastener hole in a plate, the fastener hole further provided with an expandable locking clip configured to engage a portion of the fastener to prevent the fastener from being backed out of the fastener hole, and wherein the locking clip expanding portion is configured to expand the locking clip.

15. The tool of claim 14, wherein the locking clip expanding portion is configured to expand the locking clip to a dimension greater than an outer diameter of the fastener head.

16. The tool of claim 14, wherein the locking clip expanding portion is configured to expand the locking clip to a dimension smaller than an outer diameter of the fastener head.

17. The tool of claim 16, wherein at least a portion of the fastener is configured to expand the locking clip to a dimension substantially equal to the outer diameter of the fastener head when the tool is engaged with the fastener and the tool is operated to remove the fastener from the bone plate.

18. The tool of claim 1, wherein the sleeve has a distal end configured to engage a bone surface.

19. The tool of claim 1, wherein the sleeve has a distal end configured to engage a surface of a bone plate.

20. The tool of claim 1, wherein the sleeve comprises first and second pieces, the first piece configured to threadably engage the sleeve engaging portion of the drive shaft and the second piece comprising an end configured to engage the surface of a bone plate or bone.

21. The tool of claim 19, wherein the first and second pieces are rotatable with respect to each other.

22. A bone plate, tool and fastener system comprising:

the tool of claim 1, further comprising at least one radial member,

a fastener having a radially deformable head and a threaded body, the head having a circumferential groove for engaging a bone plate locking element, and configured to receive the radial member to axially engage the tool with the fastener, and

a bone plate having at least one bone screw hole, the at least one bone screw hole having a locking element disposed at least partially within the hole and configured to engage at least a portion of the fastener head groove to axially retain the bone screw within the bone screw hole,

wherein when the fastener is retained within the bone screw hole by the locking element and the tool is axially engaged with the fastener, an axial removal force applied to the fastener by the tool causes the fastener head to radially deform to thereby disengage the fastener from the locking element.

23. The system of claim 22, wherein the fastener head is rendered radially compressible by at least one longitudinal slot disposed in the head.

24. The system of claim 22, wherein the fastener head is rendered radially compressible by a hollow portion disposed in the head.

25. A tool comprising

a drive shaft having a fastener engaging end and a sleeve engaging portion, the fastener engaging end comprising a rotational engagement portion and an axial engagement portion,

a sleeve disposed about at least a portion of the drive shaft, the sleeve comprising a drive shaft engaging portion,

wherein the sleeve engaging portion and the drive shaft engaging portion comprise complementary threads configured to allow the drive shaft to translate linearly within the sleeve when the drive shaft is rotated relative to the sleeve.

26. The tool of claim 25, wherein the drive shaft comprises a cannulated fastener driving portion and an inner shaft portion, at least a portion of the inner shaft disposed within the driving portion, the inner shaft portion configured to axially engage a fastener and the driving portion configured to rotationally engage the fastener.

27. The tool of claim 26, wherein the inner shaft portion is tapered and the cannulated fastener driving portion is configured to slidingly receive the tapered inner shaft.

28. The tool of claim 25, the fastener engaging end further comprising a locking clip expanding portion, the fastener engaging end of the drive shaft configured to engage a fastener disposed within a fastener hole in a plate, the plate having an expandable locking clip disposed within the fastener hole, the clip configured to engage a portion of the fastener to prevent the fastener from backing out of the fastener hole, wherein the fastener engaging end is configured to expand the fastener locking clip when the drive shaft engages the fastener.

29. The tool of claim 28, wherein the locking clip engaging portion is configured to expand the locking clip to a dimension greater than an outer diameter of the fastener head.

30. The tool of claim 28, wherein the locking clip engaging portion is configured to expand the locking clip to a dimension smaller than an outer diameter of the fastener head.

31. The tool of claim 30, wherein when the tool is engaged with the fastener and the tool is operated to remove the fastener from the bone plate, an axial removal force applied by the tool is greater than a fastener locking force of the locking clip.

32. The tool of claim 25, wherein the sleeve has a distal end configured to engage a bone surface.

33. The tool of claim 25, wherein the sleeve has a distal end configured to engage a surface of a bone plate.

34. The tool of claim 25, wherein the sleeve comprises first and second pieces, the first piece configured to threadably engage the sleeve engaging portion of the drive shaft and the second piece comprising an end configured to engage the surface of a bone plate or bone.

35. The tool of claim 34, wherein the second piece further comprises an inwardly-extending spring element configured to engage an outer surface of the drive shaft to provisionally retain the second piece at a selected location on the drive shaft.

36. The tool of claim 35, wherein the first and second pieces are rotatable with respect to each other.

37. The tool of claim 25, wherein the rotational engagement and axial engagement portions comprise a single screw thread element configured to engage and retain at least a portion of a fastener seated in bone.

38. The tool of claim 37, wherein when the tool is engaged with the fastener and the tool is rotated to remove the fastener from the bone, the rotation serves to increase engagement of the screw thread element with the fastener.

39. A method of removing a fastener from a bone and/or plate comprising the steps of:

(a) providing a tool having an inner shaft portion, a cannulated drive shaft portion and a sleeve portion, the cannulated drive shaft portion at least partially disposed within the sleeve portion and the inner shaft portion at least partially disposed within the cannulated drive shaft portion;

(b) inserting a portion of the drive shaft portion into the head of a bone fastener;

(c) axially engaging the inner shaft portion with the bone fastener, the fastener engaged with a bone portion, the fastener further disposed within the bone screw hole of a bone plate;

(d) rotationally engaging the inner shaft portion with the bone fastener;

(e) engaging one end of the sleeve portion with a surface of the bone plate; and

(f) moving the drive shaft and outer sleeve portions with respect to each other to remove the fastener from the bone.

40. The method of claim 39, wherein the inner shaft portion further comprises a threaded distal end configured to engage an internally threaded portion of the fastener.

41. The method of claim 39, wherein steps (b), (c) and (d) are performed substantially simultaneously.

42. The method of claim 39, the drive shaft portion further comprising an externally threaded portion configured to mate with an internally threaded portion of the outer sleeve, wherein step (f) comprises rotating the drive shaft and outer sleeve portions with respect to each other.